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College students' innovation creating the future of smaller satellites

The Space Vehicle Directorate's University Nanosatellite Program promotes imaginative and progressive approaches to spacecraft design, development, and flight

Several college campuses across the country have discovered and experienced a new competitive endeavor not occurring in stadiums or arenas, but in classrooms and laboratories – creating the future of small satellite technology.

Initiated five years ago as a joint Defense Advanced Research Projects Agency/Air Force Research Laboratory/Air Force Office of Scientific Research/Space Vehicles Directorate/National Aeronautics and Space Administration funded payload to launch multiple spacecraft from the Space Shuttle, the University Nanosatellite Program has developed into an effective outreach to approximately 1,000 students who represent the next generation of aerospace employees.

“Educational outreach is important to me, as I was not given the opportunity to work on a satellite when I was in college,” said Scott Franke, University Nanosatellite Program manager. “The program allows students who have not necessarily been involved in space to be right there within arm’s length.”

Generally designed for multiple spacecraft tasks and/or formation flying, the nanosatellite weighs below 10 kilograms (22 pounds). On the other hand, one of the participating universities has explored employing a larger “mother” nanosatellite with a picosatellite-sized harbored vehicle of less than one kilogram (2.2 pounds). Together, they would form a particular nanosat design, with the whole system meeting the program requirements of less than 30 kilograms (66 pounds). Nevertheless, advantages of miniature spacecraft include inexpensive design, availability for mass production, reduced launch price, fuel economy and low risk cost. As a result of the thrift factor, the program has afforded student participants with a valuable learning platform, which encourages maximum innovation and creativity in small satellite design, development, and flight.

During the program’s beginning, the Dept. of Defense selected approximately 10 universities to work on five separate nanosatellite projects known as the Three Corner SAT; Emerald; Constellation Pathfinder; Solar Blade Nanosat and Ionospheric Observation Nanosatellite Formation (ION-F). Three programs involved college alliances, and two of the teams partnered on NanoSat-2, which consisted of the Three Corner SAT and the ION-F. Students from Arizona State, Colorado, and New Mexico State Universities designed and constructed Three Corner SAT, comprised of three identical nanosats, which would, in flight, exhibit data handling, stereo imaging, innovative command, cellular-phone communications and formation flying.

Likewise, the ION-F nanosat project featured collegians from Utah State, Washington, and Virginia Tech Universities working on three miniature spacecraft

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(one per school) dedicated to examining worldwide ionospheric effects impacting the performance of space-based radars and other distributed satellite dimensions; accomplishing formation flying and constellation communication; demonstrating new technologies such as an Internet-based operations center, micro-thrusters, advanced tether system and attitude control; as well as web-based control of a distributed space system. Originally, the two experimental satellites were to be launched in one configuration, but due to the Space Shuttle Columbia's explosion in February 2003, the program experienced three additional design changes before being the only payload launched aboard the inaugural Delta IV heavy rocket, provided by the Space and Missile Systems Center's Space Test Program, from Cape Canaveral, Fla., in December 2004. The mission objective involved testing of autonomous communications between the two satellites and taking photographs of the upper atmosphere.

Shortly after liftoff, however, the Delta IV launch vehicle encountered problems and inserted the NanoSat-2 into an improper orbit. As a result, the flight control team located at the University of Colorado at Boulder, operated the spacecraft for less than a day. Nevertheless, it was not back to the drawing board, as work on NanoSat-3 had commenced in 2003.

Approximately 13 universities participated in the NanoSat-3 competition, and a panel of 15 judges, with one-third of the group comprised of Air Force Research Laboratory personnel, selected the University of Texas' entry, known as FASTRAC. In early 2006, the nanosatellite will be delivered to the Space Vehicles Directorate, Kirtland Air Force Base, N.M., from Austin, Texas, to begin integration and testing. Program goal is to have the spacecraft launch ready by February 2006 to perform its global positioning system mission. In addition, the NanoSat-3 flight will demonstrate four technology areas of interest to the Space Vehicles Directorate: responsive space; micro-discharge plasma thruster; low-cost miniature satellite technologies and formation flight.

"The University of Texas has the opportunity with NanoSat-3 to fly an affordable, low-weight GPS experiment that demonstrates commercial, off the shelf technology," the University Nanosatellite Program manager said.

On the other hand, several of the schools not selected as program finalist have sought flights for their satellites elsewhere. Nonetheless, while work progressed on preparing NanoSat-3 for flight, another 11 universities were chosen in January 2005 to compete for NanoSat-4, with the final product to be delivered to the selection panel in March 2007. The Air Force Office of Scientific Research has funded \$700,000 for the participating schools with the Space Vehicles Directorate continuing to provide program administrative and design oversight. As a testimony to teamwork, as well as to diversity in age and educational experience, students from the Ph.D. level to freshman year in college have worked on NanoSat-2 through Nanosat-4.

"The program is a pipeline of satellites every two years. Each time, an upgrade to the design is made," said Franke. "It is a progressive pipeline."

Currently in the concept stage, NanoSat-5 will likely feature the launch of two to three selected satellites, with the idea of having more schools fly their experiments.

The program is also investigating employing a standardized bus design for the competition, which begins in March 2007.

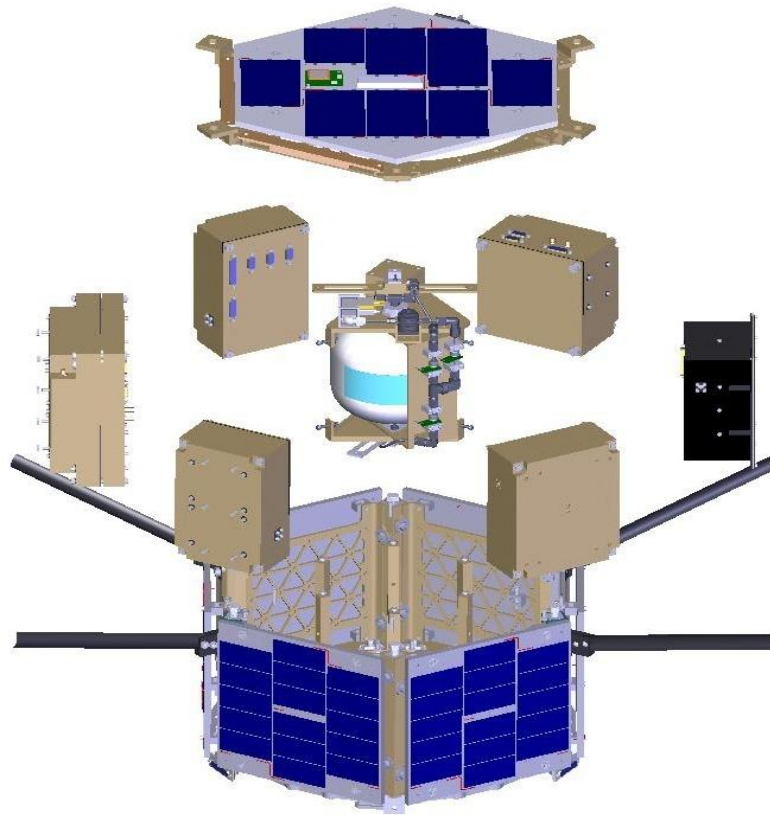
As evidenced by the University Nanosatellite Program, interest today in designing, developing, and flying the miniature spacecraft of tomorrow has significantly increased in America's halls of higher learning.



University of Texas students surround their NanoSat-3 winning design and demonstrate the “Hook’em Horns” sign, which is a familiar sight at the school’s athletic events.



NanoSat-2 undergoing integration and testing at Cape Canaveral, Fla.



The interior and exterior sections comprising NanoSat-3, which when launched in 2006, will pursue responsive space goals and demonstrate nanosatellite technologies.



NanoSat-3 FASTRAC logo